

Setting

Northwestern Fiord is an irregular inlet on the Gulf of Alaska Coast in the Kenai Mountains, Alaska. As late as 1900, Northwestern Glacier completely filled the fiord, ending on a terminal-moraine bar which encloses the inlet. Between 1894 and 1960 the glacier made a drastic retreat of 9.4 mi (15 km), exposing this deep fiord which presents views of scenic grandeur remarkable even for Alaska.

Due to its isolation and to the hazardous, unsurveyed moraine bar at its entrance, Northwestern Fiord has rarely been visited, and no detailed scientific surveys of the inlet were made prior to 1978. In June of that year the U.S. Geological Survey Research Vessel *Growler*, investigating the dynamics of drastically retreating calving glaciers, anchored outside the fiord and sent ahead a dory equipped with a portable depth sounder to determine the water depth over the terminal-moraine bar. This dory party soon returned proudly claiming to have discovered, at last, the famous "Northwest Passage" sought in vain by such eminent explorers as Columbus, Cabot, and Cook. The RV *Growler* then crossed the bar and obtained new field data reported here.

Bathymetry

In 1928, the U.S. Coast and Geodetic Survey (now National Oceanographic and Atmospheric Administration-NOAA) surveyed Harris Bay; except for a few figures (which are underlined) obtained by the U.S. Geological Survey, the soundings shown southeast of the terminal moraine bar (sheet 1) were transferred from their Hydrographic Survey H-4837, scale 1:20,000, dated September 1928.

Within the inlet, the soundings shown on sheet 1 were obtained by the RV *Growler* with a Ross 400B* depth recorder; positions were obtained with a Decca 110 navigation radar equipped with a precision measuring device. In the shoal areas in proximity to the terminal moraine and along various shorelines, soundings were obtained with a Ross SL 600C depth recorder mounted aboard an outboard-powered dory; these lines were run visually between identifiable points on shore. Both plotting methods are imprecise, and the positions of soundings are approximate. Soundings were adjusted to approximate lower low water from plots made from predicted tides for nearby stations published by the National Ocean Survey, NOAA. Soundings were obtained only in the areas shown, and undetected shoals and rocks dangerous to navigation may exist.

*The use of brand names or model numbers in this report does not imply endorsement by the U.S. Geological Survey.

Sediment Accumulation

During the drastic retreat of Northwestern Glacier sediment has been rapidly deposited in the fiord. The thicknesses of these deposits have not been measured, but the areas of accumulation can be recognized by soundings and profiles which show a flat, featureless bottom. The low gradients of the deposits show that these sediments have flowed into and ponded in the deepest basins (profiles A-A' B-B'). Profiles C-C' and D-D' have U-shaped profiles, indicating little sediment accumulation at considerable depth. All the shallow areas in the various coves except Northwestern Lagoon have a hard, rocky bottom; the lagoon, which is outside the terminal moraine, was not subject to neoglacial ice erosion.

Changes in Water Depth on Terminal-Moraine Bar

Grant and Higgins (Map A) show the northern side of Northwestern Glacier ending on a beach; their photographs Nos. 142 and 230 confirm that the glacier in this area ended in a low, thin front, unlike a calving glacier ending in water.

The 1928 U.S. Coast and Geodetic Survey (NOAA) hydrographic survey shows a series of boulders and sunken rocks extending practically all the way across the entrance to the fiord. With the retreat of the glacier, tidal currents and iceberg scouring evidently began eroding the moraine, especially on the north side of the bar. The 1964 Alaska Earthquake caused a subsidence of 6.7 ft (2 m) in the vicinity of Northwestern Fiord (Piafker, 1969, plate 1), and several islands on the moraine were submerged below high tide. It appears that a channel with a maximum depth of about 35 ft (10 m) (profiles E-E' and F-F') is now present where a beach existed in 1909 and rocks were visible at low tide in 1928, perhaps as a result of both erosion and earthquake subsidence.

Drastic retreat of Northwestern Glacier

When observed in 1909 by Grant and Higgins (1913), Northwestern Glacier nearly filled the fiord, ending about 1200 ft (365 m) from the terminal-moraine bar (map A, this sheet). The height of the lateral trimlines above the ice surface was estimated to be 120 to 150 ft (36 to 45 m), and Grant and Higgins estimated that the glacier had retreated in the previous 10 to 15 years from the trimline and moraine (hooked line dated 1894). Evidently Northwestern Glacier had just started to retreat in 1909; the 1928 U. S. Coast and Geodetic Survey (NOAA) hydrographic survey shows the glacier ending about 0.5 mi (0.8 km) from the moraine shoal at a point where the water presently has a maximum depth of 400 ft (122 m) (hooked line dated 1928). By 1942, when photographed by the Army Air Force for reconnaissance mapping, the glacier had retreated about 4 mi (6.4 km), and terminated as a high, irregular ice cliff with a deep, concave embayment near the northern side where the fiord now has a maximum depth of 965 ft (294 m) (hooked line dated 1942). The retreat continued and by 1950, when the U.S. Geological Survey photographed the area for topographic mapping, the glacier ended in a long, concave front extending from rocks west of Erratic Island to Striation Island, and as a high ice cliff blocking Polished Passage north of the island (hooked line dated 1950). By 1960 the glacier had retreated an additional 2.5 mi (4 km), and it then terminated at a retracted, stable position near the head of tidewater.

Relationship of Rate of Retreat to Water Depth

The rate of retreat was clearly related to water depth; between 1900 and 1927 the glacier was retreating off the shoals of the terminal-moraine bar at an average rate of 120 ft (36 m) per year. Between 1927 and 1964, while the glacier terminated in deep water, the rate of retreat averaged about 1500 ft (457 m) per year. This rate of retreat is considerably lower than for nearby McCarty Glacier (Post, 1979), which in part may be due to the irregularity of the channel.

Changes Since 1964

Since 1964 the Northwestern Glacier has fluctuated slightly with annual changes often exceeding longer term changes. Four of the glaciers which formerly were tributaries of Northwestern Glacier now have relatively low mean altitudes and are retreating. The steep glaciers draining the high neve' basins west of the fiord have remained very active, and Anchor and the next glacier south have thickened and advanced in their lower reaches. Approximate terminal and lateral positions for various glaciers are shown by dated hooked lines.

Neoglacial Advance of Northwestern Glacier

Because forests grew in other Alaskan fiords during hypothermal time a careful search was made for evidence of vegetation which predated Northwestern Glacier's neoglacial advance. Near the mouth of the fiord new forests have already covered areas deglaciated in recent decades, and no fresh-cut exposures of glacial till or outwash were noted where debris of former forests could be identified. The first positive evidence of preadvance vegetation was a 3-inch by 3-foot segment of a small tree, found loose 20 ft (6 m) above sea level on the outwash plain in front of Northeastern Glacier. This sample (UW-515) had a carbon-14 date of 1635 ± 100 years before present (B.P.). Near the head of the fiord, only 1 mi (1.6 km) from the present terminus of Northwestern Glacier, two 6-inch (16 cm) battered wood fragments were found which, from the nature of the wood and grain, came from trees a foot (30 cm) or more in diameter. This forest debris, situated 200 ft (61 m) above sea level in a former stream channel immediately below Redstone Glacier, had been recently washed out from under the retreating front. The carbon-14 age of one of these fragments (UW-516) was 1,385 ± 55 years B.P. As valley glaciers generally terminate several miles downstream from the last living trees on the valley walls, it is possible that the glaciers advanced considerably before this wood was buried by the ice. The date does disclose that trees still grew at some point in this valley about 1400 years ago.

Unofficial Names

The names of Northwestern Fiord, Northwest Passage, Ogive Glacier, Anchor Glacier, Redstone Glacier, Southwestern Glacier, Northeastern Glacier, Pagana Glacier, Sunlight Glacier, Striated Island, Erratic Island, and Polished Passage are unofficial.

References

Grant, U.S., and Higgins, D.F., 1913, Coastal glaciers of Prince William Sound and Kenai Peninsula, Alaska: U.S. Geological Survey Bulletin 526.

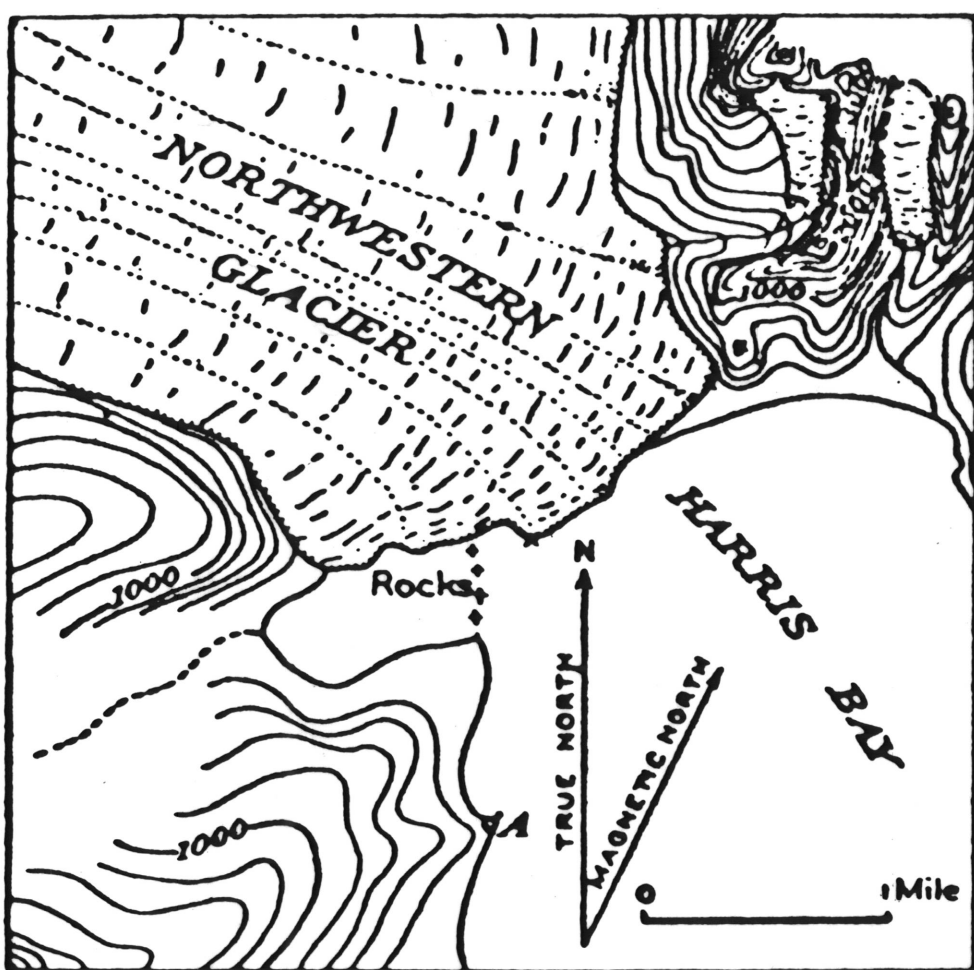
Piafker, George, 1969, Tectonics of the March 27, 1964 Alaska Earthquake: U.S. Geological Survey Professional Paper 343-I, plate 1.

Post, Austin, 1980, Preliminary bathymetry of McCarty Fiord and neoglacial changes of McCarty Glacier, Alaska: U.S. Geological Survey Open-File Report 80-424, 4 sheets.

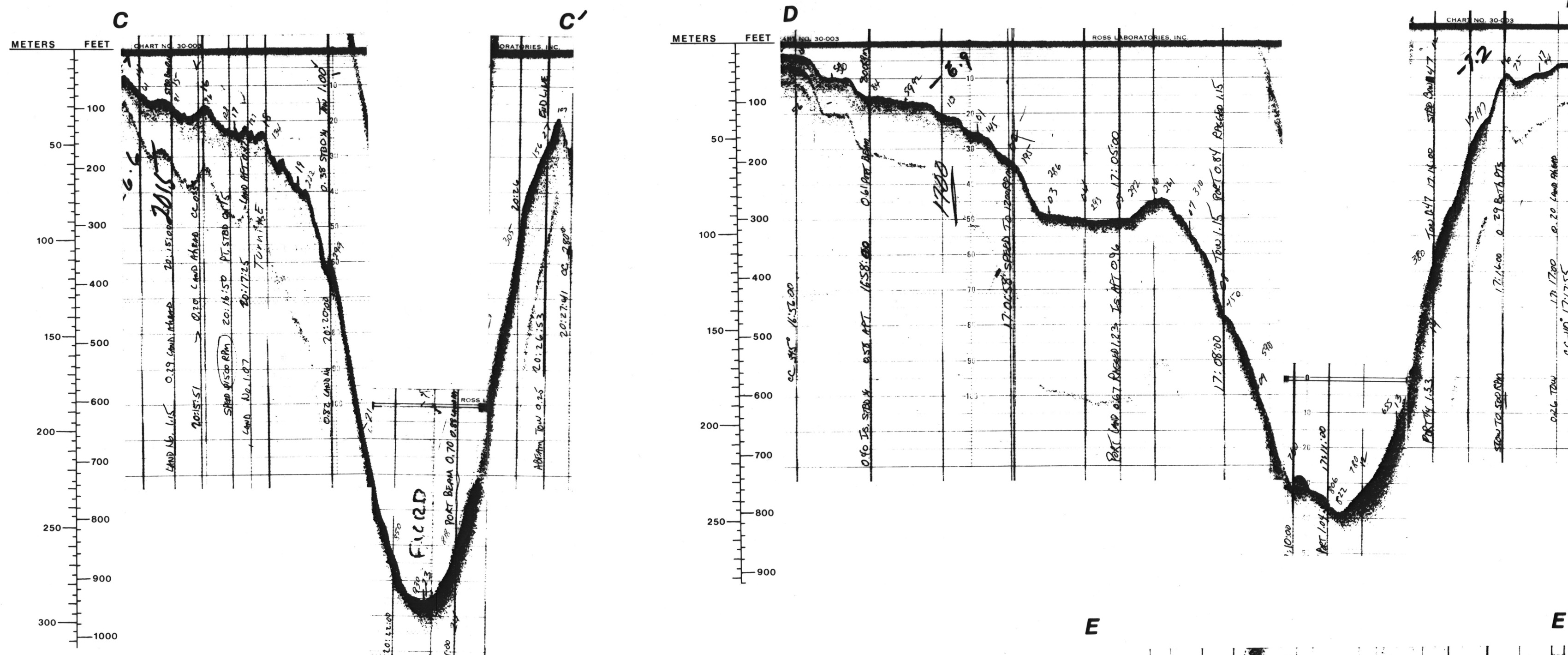
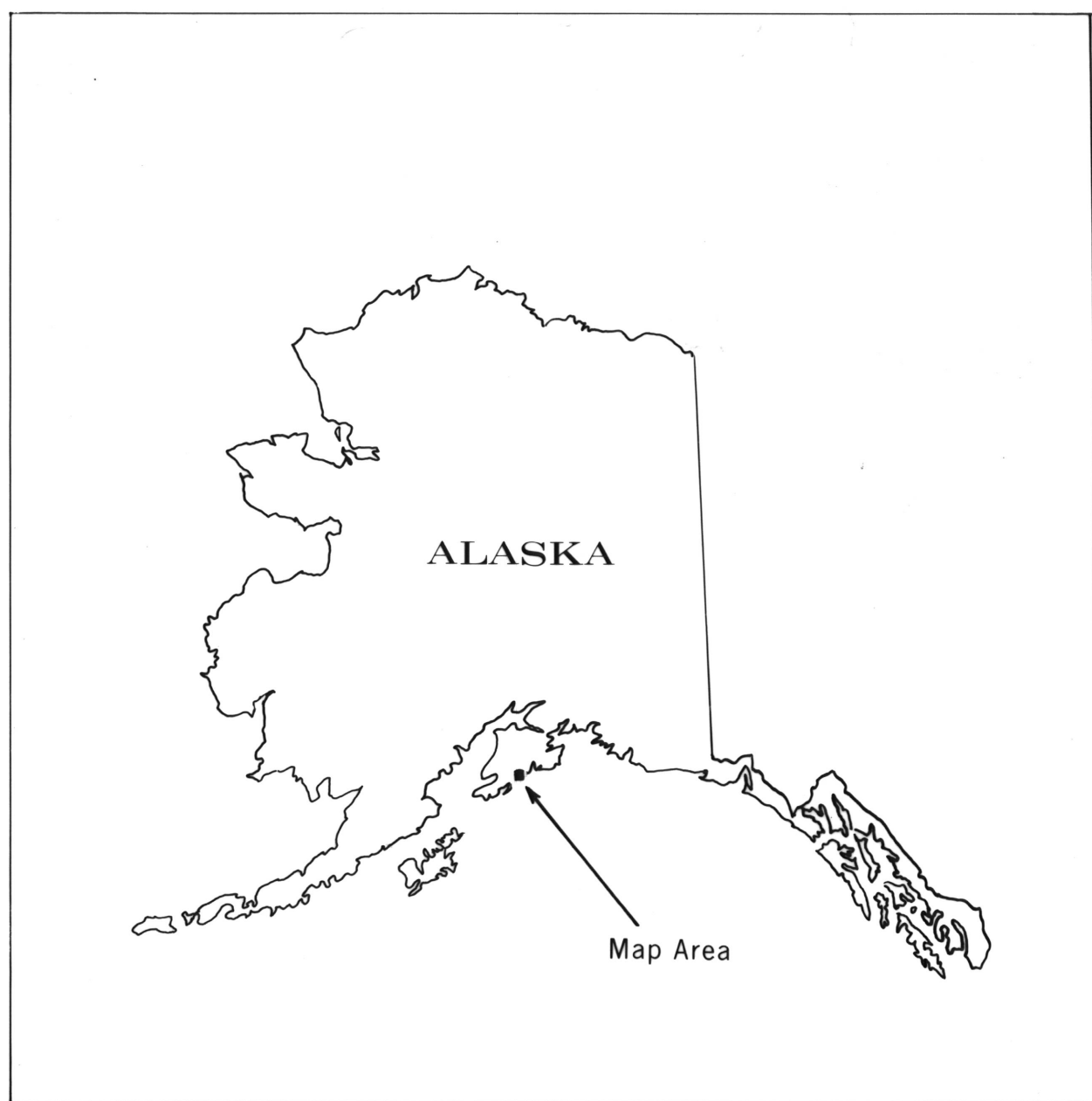
U.S. Coast and Geodetic Survey, 1928, Alaska, Kenai Peninsula, Harris Bay: Hydrographic Survey H-4837, scale 1:20,000, 1 sheet.

Acknowledgments

This study was aided by instruments, charts, and data provided by the National Ocean Survey, National Oceanic and Atmospheric Administration. The U.S. Coast Guard provided logistical assistance. Carbon-14 dating was done by the University of Washington, Seattle, Wash.

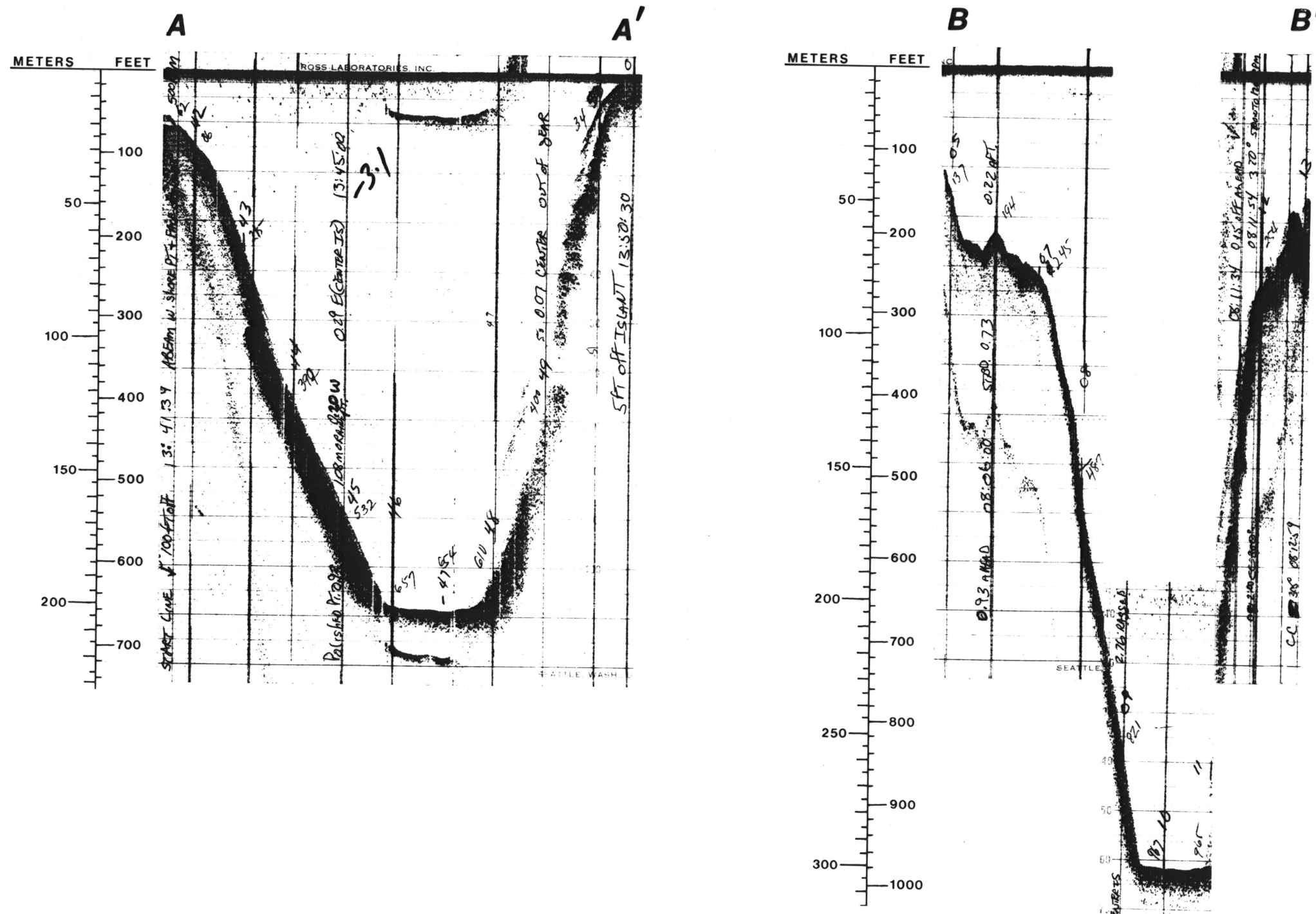
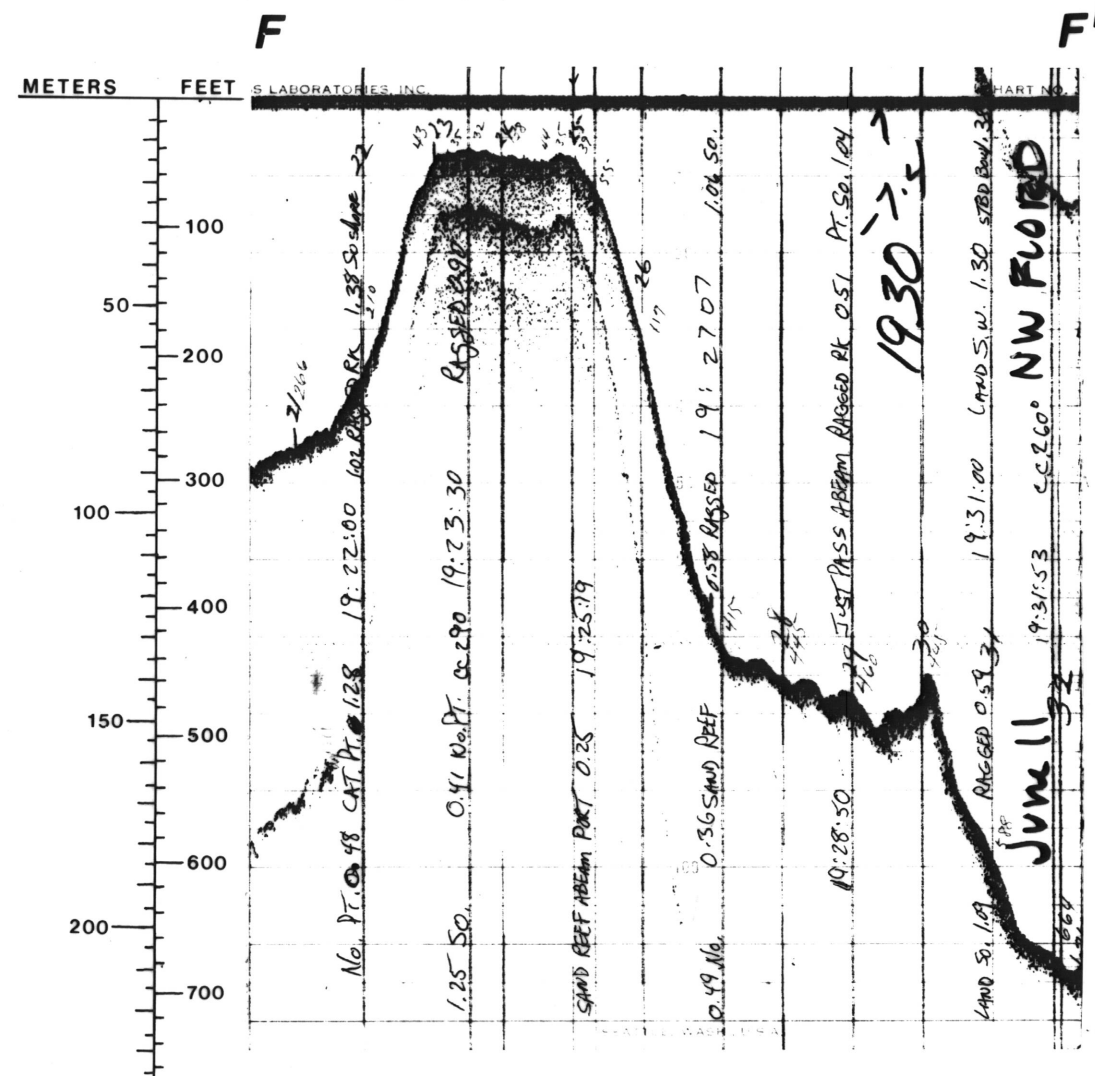
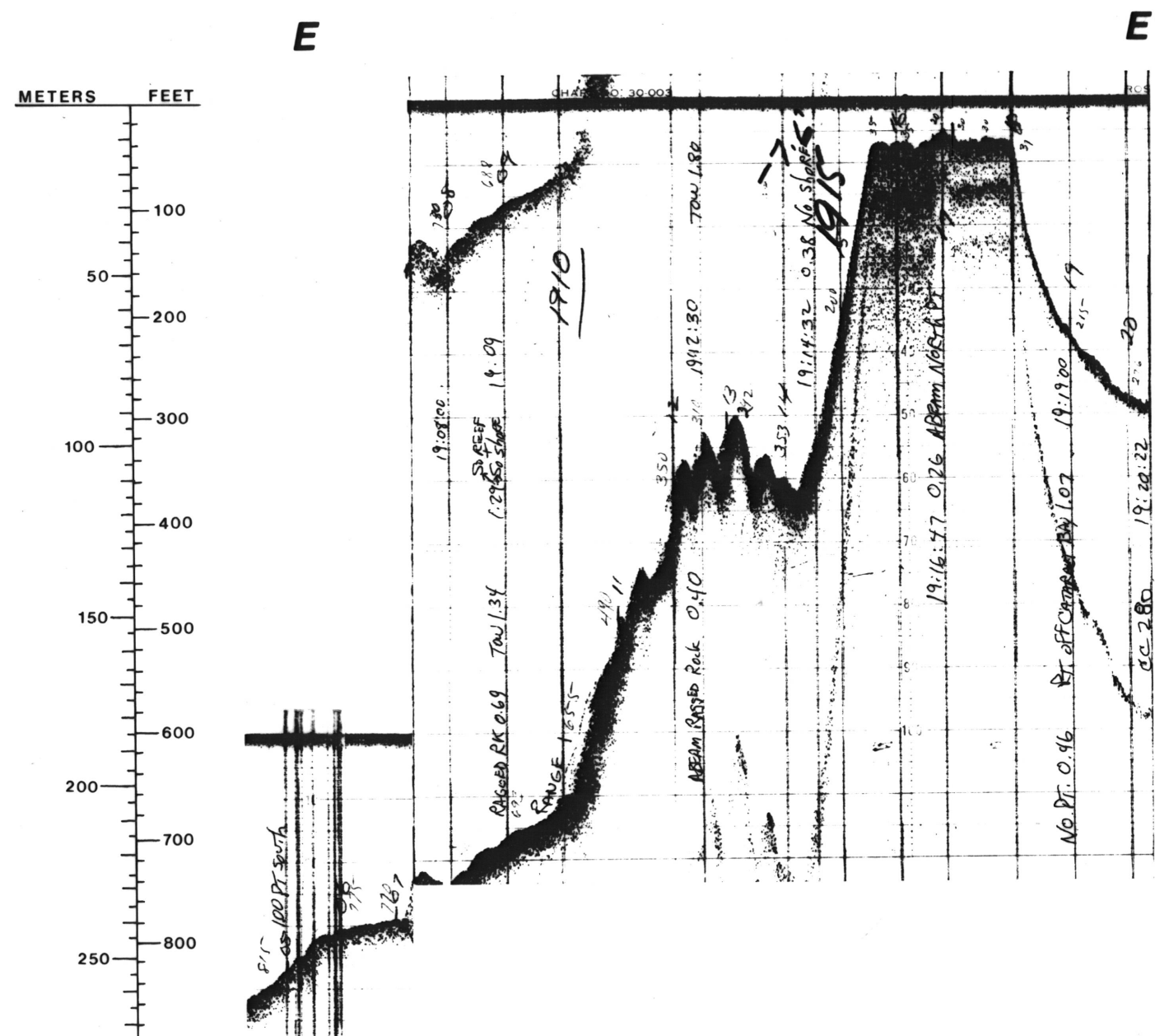


Sketch map of front part of Northwestern Glacier, July 23, 1909
Map A. Enlarged from Grant and Higgins, 1913, fig. 12.



Profiles

The profiles shown are photographic copies of original depth-recorder charts which are scaled in either meters (Ross SL 600C) or fathoms (Ross 400B). The scales for meters and feet shown at the left of each profile have been adjusted to correct for tidal effects when required. Hand-written notes on charts are generally navigation data.



Explanation

- Approximate position of dated glacier terminus position or trimline: heavy line where glacier terminated in water.
- Approximate areas of thick sediment deposits
- Exposure of preneoglacial forest debris
- ¹⁴C (carbon-14) dated preneoglacial forest debris

PRELIMINARY BATHYMETRY OF NORTHWESTERN FIORD AND
NEOGLACIAL CHANGES OF NORTHWESTERN GLACIER, ALASKA

SCALE 1:20,000

DEPTH CURVES IN FEET. DATUM IS APPROXIMATE MEAN LOWER LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 6 FEET

By
Austin Post
1980